ECONOMY

LEVERAGING UNIVERSITY EXPERTISE TO INFORM BETTER POLICY

Integrated Energy Policy Report Workshop

Alternative Renewable Fuels and
Vehicle Technology Program (ARFVTP)

June 12, 2014

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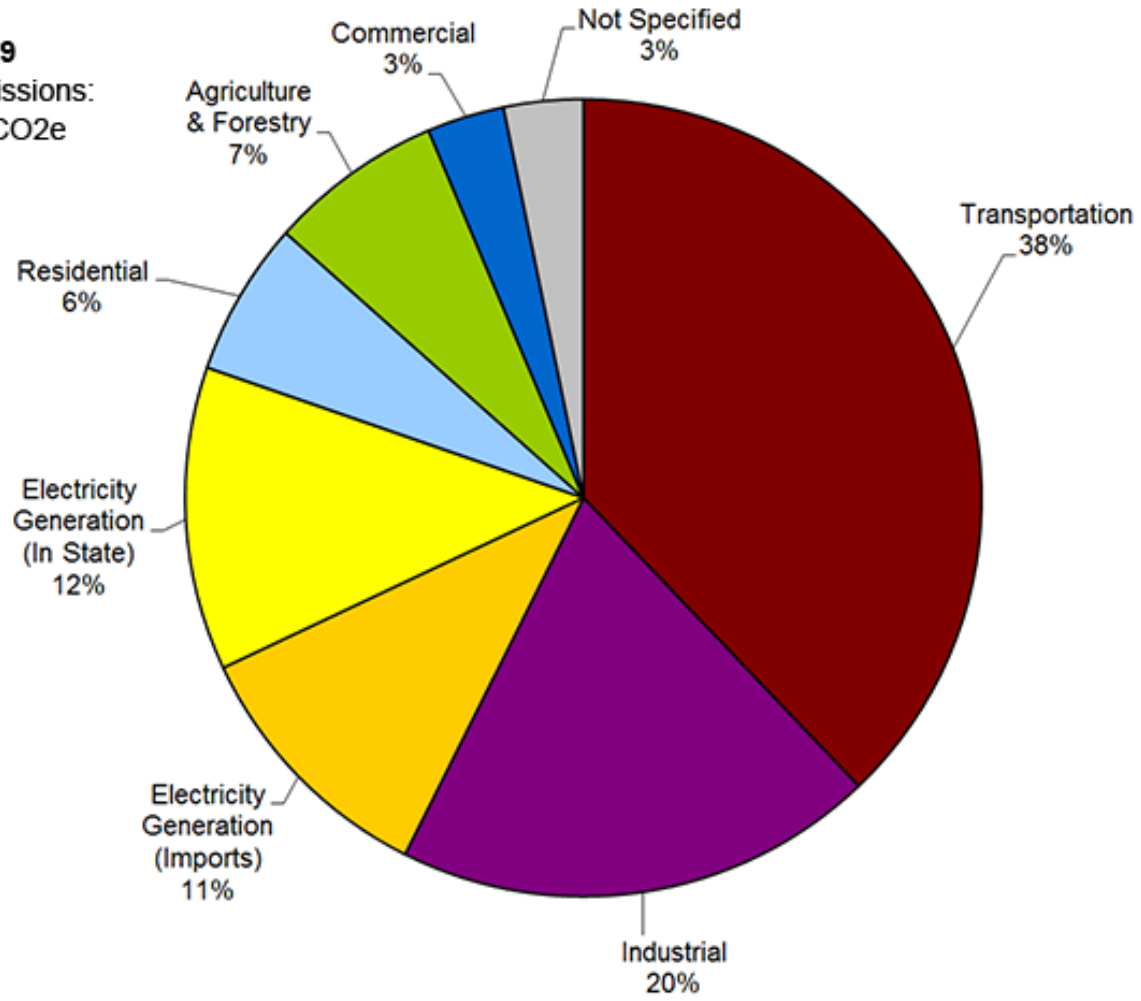
PRESENTATION OVERVIEW

- California by the numbers
- Policy Objectives as Investment Criteria
- Investment strategy – step by step
- Project Criteria and Metrics - what to measure and when?
- Data collection and review
- Do → Learn → Adapt

California Greenhouse Gas Emissions (GHG)

Transportation including refining = ~200 MMTCO2e/ year (~44% of total)



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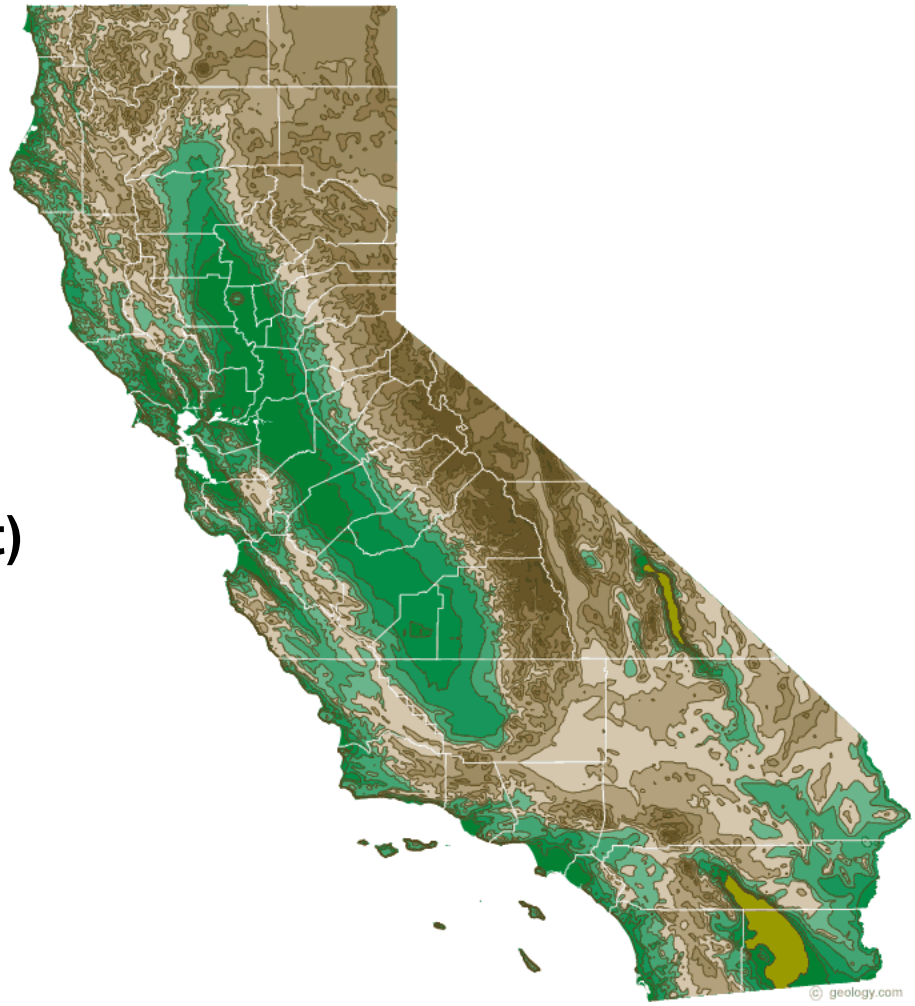
Source: ARB Greenhouse Gas Emissions Inventory: http:// www.arb.ca.gov/cc/inventory/inventory.html

California Energy – By the Numbers

GDP ~$1.96 Trillion (2011)

Energy Expenditures (2010)
~$33.4B Electricity
~$15B Natural Gas
~$72B Petroleum (~2/3 Transport)

Total ~ $320Million/day (2010)



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Sources: US DOE Energy Information Administration, California Energy Commission

Policy Objectives, Goals and Milestones

Policy Objectives	Goals and Milestones
Global Warming Solutions Act (AB32) and Exec Order S-3-05	Reduce GHG emissions to 1990 levels by 2020 and 80% below 1990 levels by 2050
Petroleum Reduction	Reduce petroleum fuel use to 15% below 2003 levels by 2020
In-State Biofuels Production	Produce in California 20%of biofuels used in state by 2010, 40% by 2020, and 75% by 2050
Low Carbon Fuel Standard	10% reduction in carbon intensity of transportation fuels in California by 2020
Air Quality	>80% reduction in Nox by 2023 and >90% reduction in 2032.
Governor Brown's ZEV Executive Order and Action Plan	ZEV ready by 2015; Infrastructure to accommodate1M ZEVs by 2020; 1.5M ZEVs by 2025 80% reduction in Transportation GHG's by 2050

Policy Objectives (AB 8 Statute)

44272.

(a) The Alternative and Renewable Fuel and Vehicle Technology Program is hereby created. The program shall be administered by the commission. The commission shall implement the program by regulation pursuant to the requirements of Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code. The program shall provide, upon appropriation by the Legislature, competitive grants, revolving loans, loan guarantees, loans, or other appropriate funding measures, to public agencies, vehicle and technology entities, businesses and projects, public-private partnerships, workforce training partnerships and collaboratives, fleet owners, consumers, recreational boaters, and academic institutions to **develop and deploy innovative technologies that transform California's fuel and vehicle types to help attain the state's climate change policies. The emphasis of this program shall be to develop and deploy technology and alternative and renewable fuels in the marketplace, without adopting any one preferred fuel or technology.**

http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB8

Project Criteria/Metrics (AB 8)

(c) The commission shall provide preferences to those projects that maximize the goals… based on the following criteria, as applicable:

- Measureable transition from petroleum to diverse portfolio of viable alt-fuels
- Consistency with climate change policy and low-carbon fuel standards
- Ability to reduce AQ pollutants/toxics and avoid multimedia impacts
- Decrease life-cycle discharge of water and other pollutants
- No adverse impacts on sustainability of natural resources
- Provides non-state matching funds
- Provides economic benefits and promotes California firms and jobs
- Reduce life-cycle emissions by >10%
- Uses alternative fuel blends of >20% with preference for higher blends
- Drives new technology advancement for vehicles and equipment and promotes the deployment of that technology in the marketplace

(d) The commission shall rank applications for projects proposed for funding awards based on solicitation criteria developed in accordance with subdivision (c), and shall give additional preference to funding those projects with higher benefit-cost scores.

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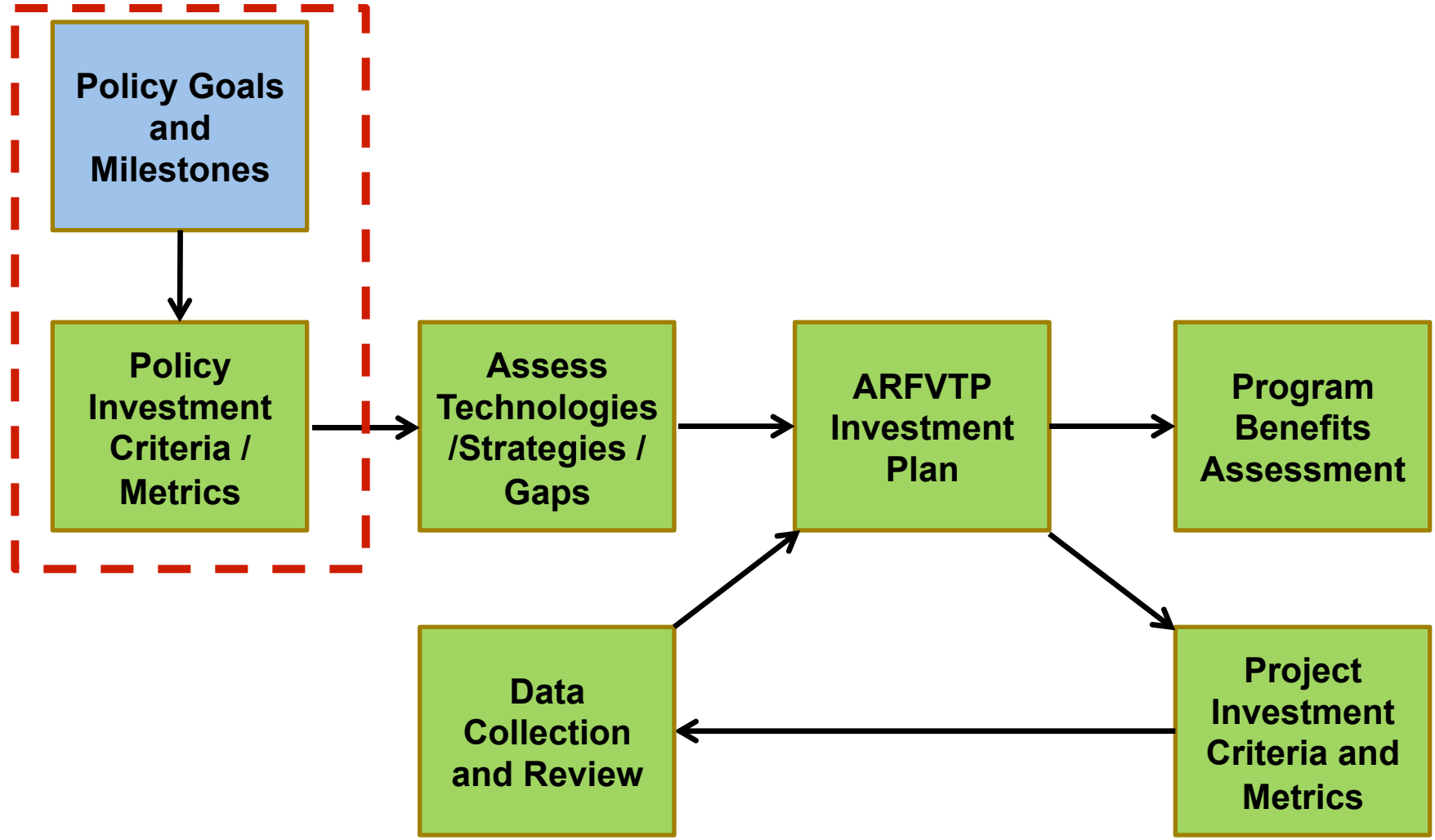
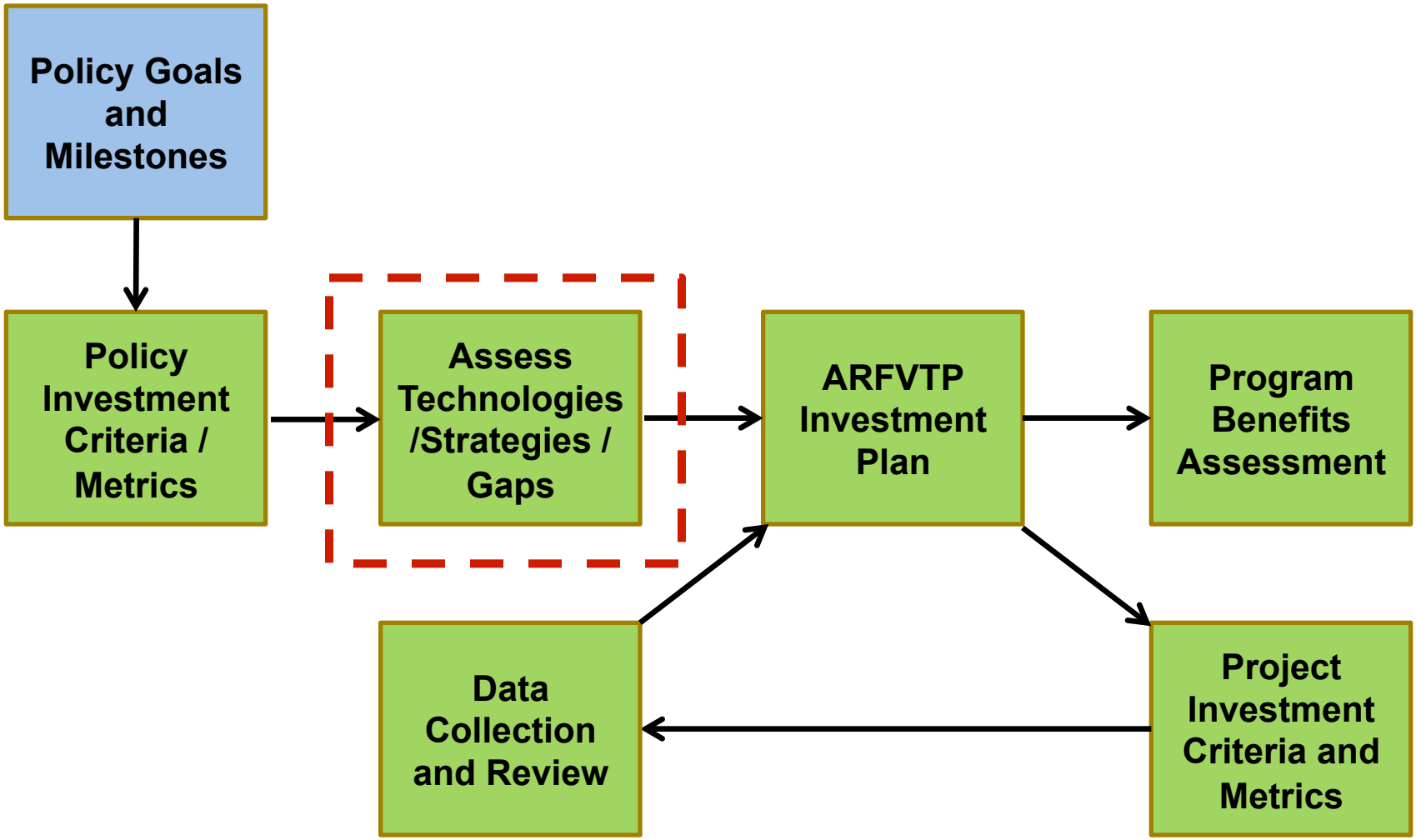
Investment strategy step by step – Illustrative



Policy Objectives as Program Investment Criteria

Policy Objectives	Investment Criteria (Metrics?)
Global Warming Solutions Act (AB32) and Exec Order S-3-05	Potential for GHG reductions in 2020 and 2050
Petroleum Reduction	Potential for petroleum reductions in 2020
In-State Biofuels Production	Potential for in-state biofuel production in 2010, 2020, and 2050
Low Carbon Fuel Standard	Potential for carbon intensity reduction in 2020
Air Quality	Potential for NOx reduction in 2023 and 2032
Governor Brown's ZEV Executive Order and Action Plan	Potential for ZEV readiness in 2015, Infrastructure in 2020, and vehicles in 2025. Potential for GHG reductions in 2050

Investment strategy step by step – Illustrative



Policy Goal: GHG Reductions in 2020 and 2050

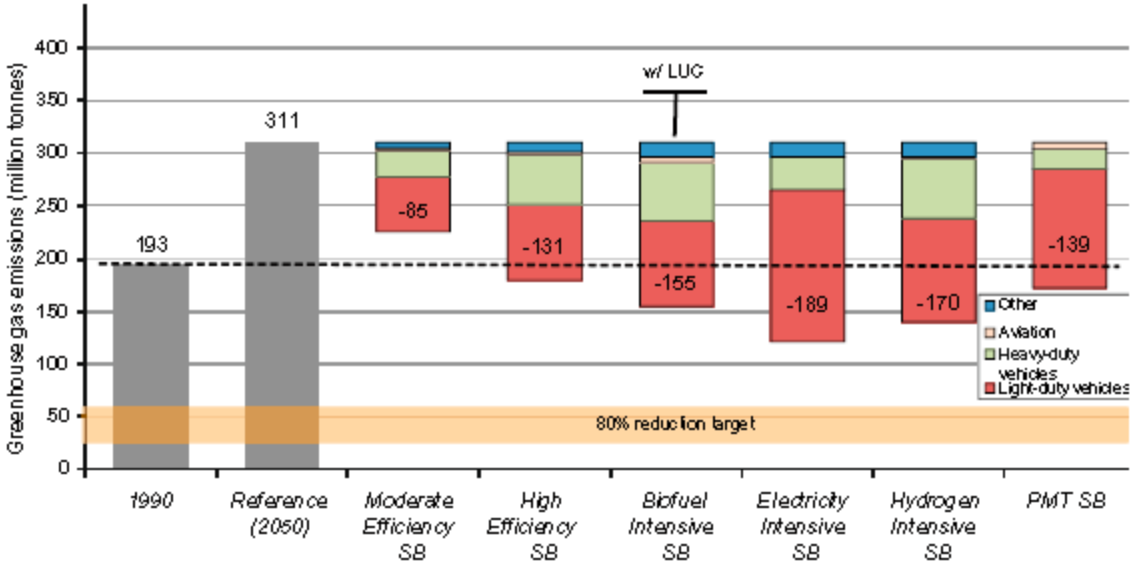


Fig. 1. Greenhouse gas emission reductions for Silver Bullet scenarios relative to Reference scenario for Instate emissions.

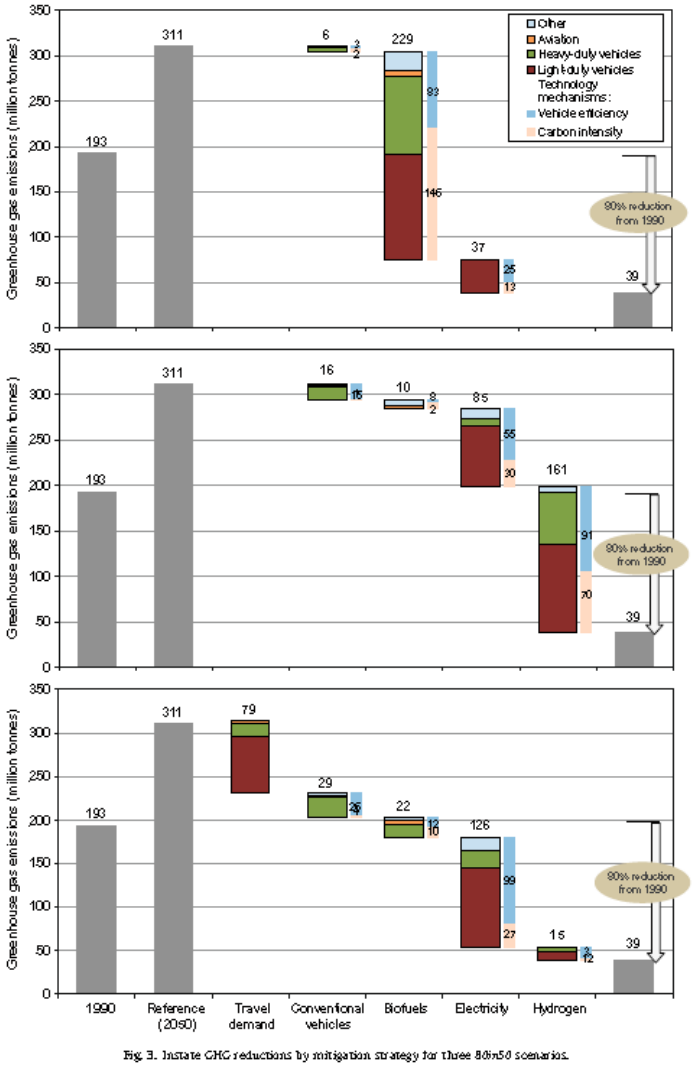


Fig. 3. Instate GHG reductions by mitigation strategy for three 80in50 scenarios.

Key findings:

- Portfolio of advanced biofuels (esp. for MD/ HD), hydrogen and electricity for LDV and more efficient land use can meet the goals
- Significant efficiency improvements needed across all vehicles types in all scenarios

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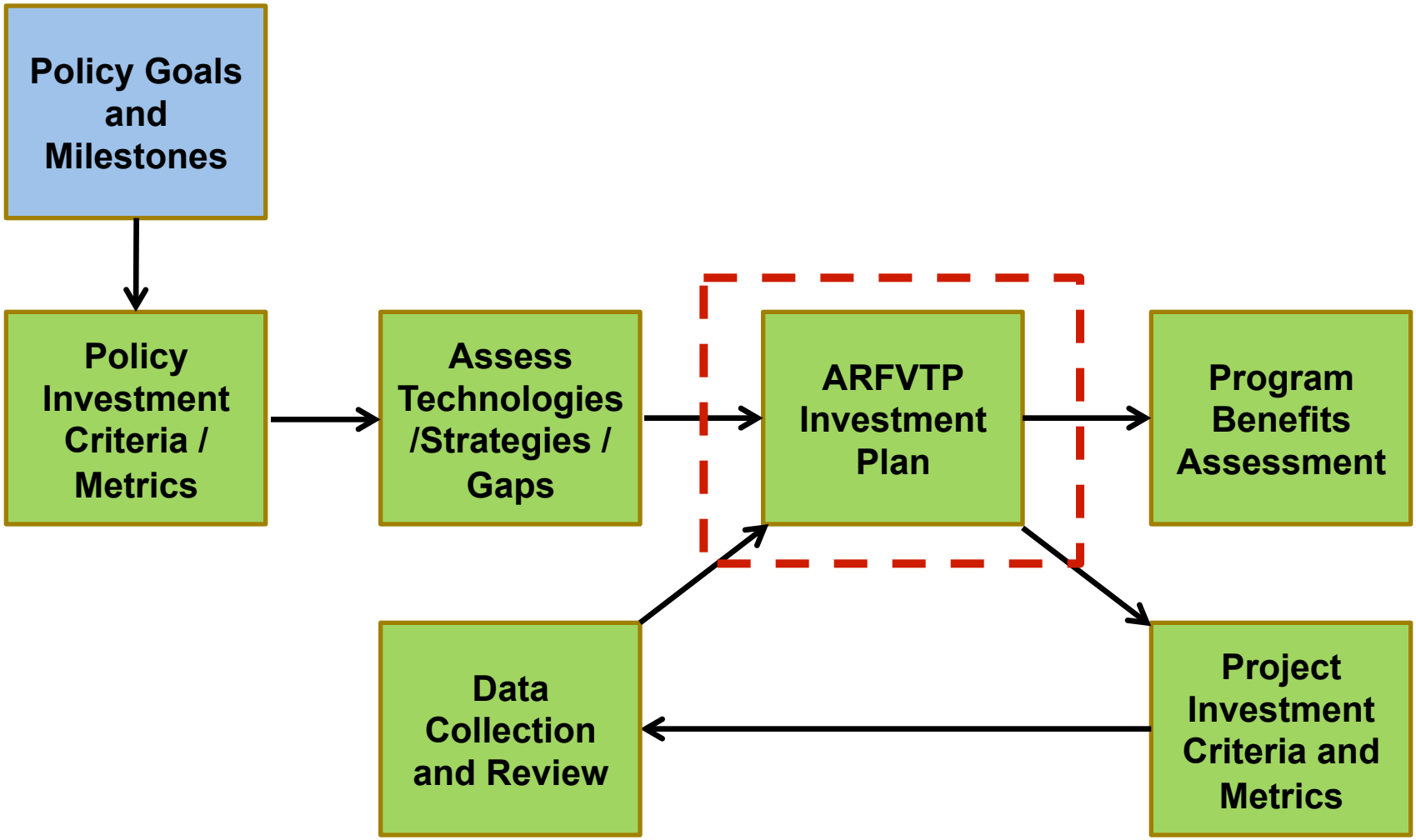
Yang, Christopher, David L. McCollum, Ryan W. McCarthy, Wayne Leighty (2009) "Meeting an 80% Reduction in Greenhouse Gas Emissions from Transportation by 2050: A Case Study in California", 14D (3), 147 - 156

Policy Objectives → Assess Technologies and Strategies

Objective / Investment Type	AB32	Petroleum reduction	In State Biofuels	LCFS (10%)	AQ	ZEV EO
Advanced Biofuels	✓	✓	✓	✓		
NG/RNG	✓	✓	✓	✓	✓	
PEV/Charging	✓	✓		✓	✓	✓
Hydrogen/FCV	✓	✓		✓	✓	✓

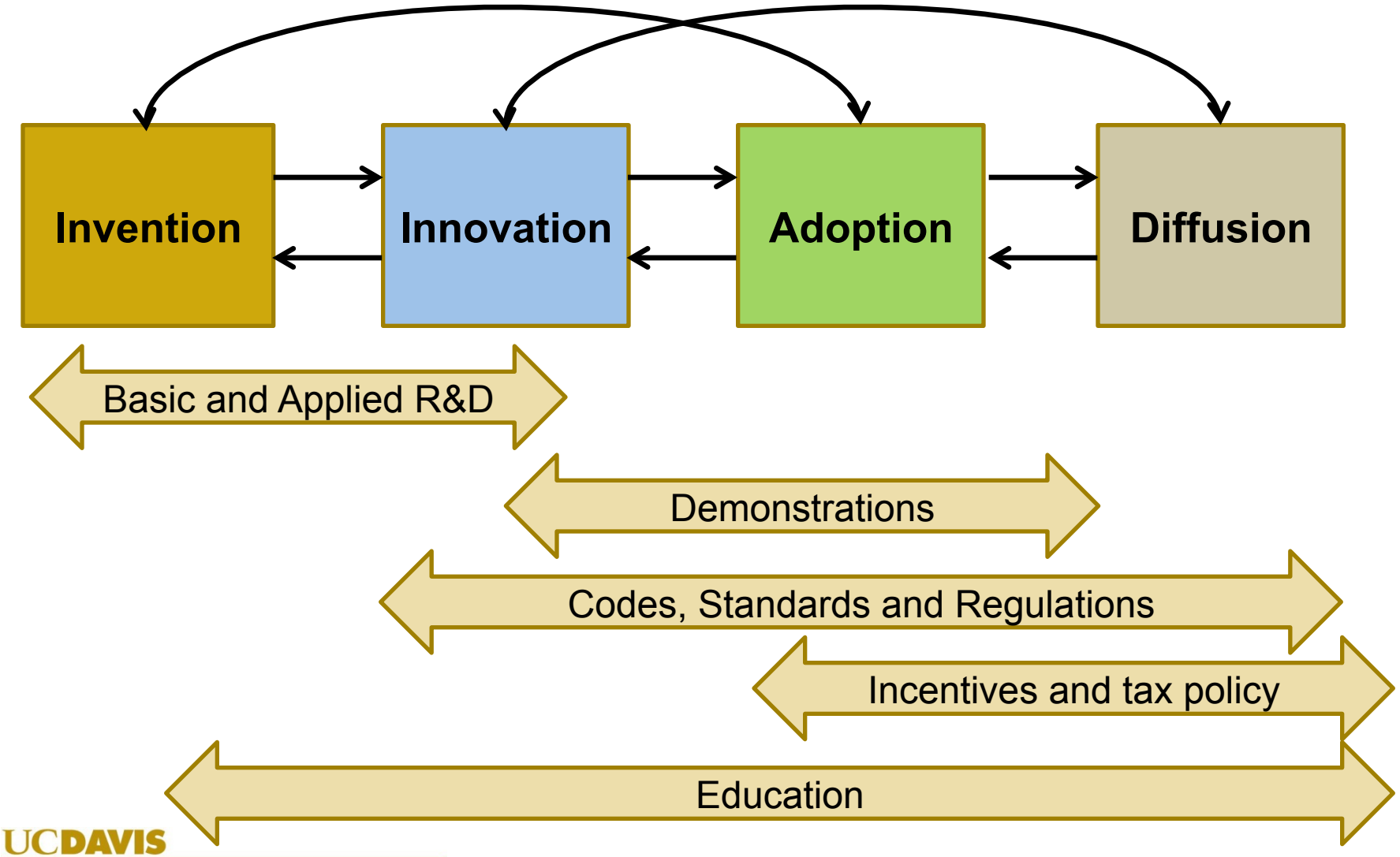
Investment strategy step by step – Illustrative



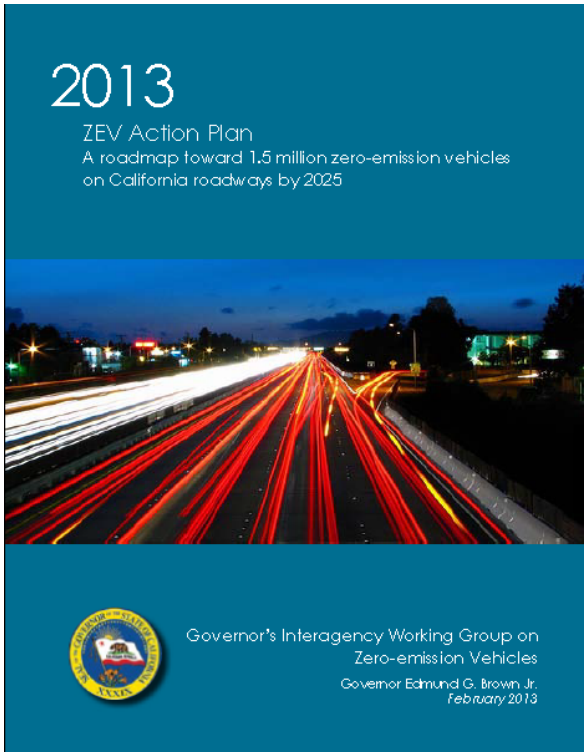
Investment Criteria - Key Questions:

1. Could the technology or strategy materially contribute to one or more of the policy goals in the desired timeframes?
2. Do specific technical/policy/market barriers exist that prevent the technology or strategy from contributing to the goals?
3. Could public investment make a material contribution to overcoming those barriers?
4. Once overcome, is there a strong business case for private investment?
5. Do the public benefits of overcoming those barriers exceed the costs?

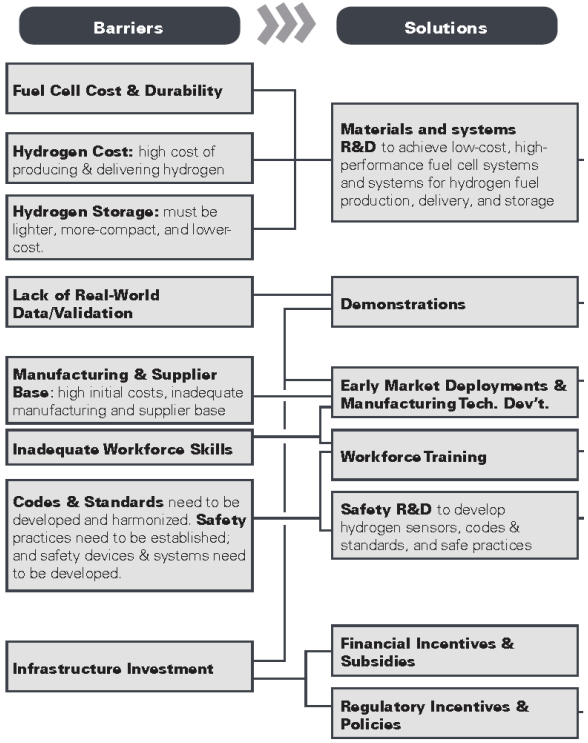
Role of government in technology innovation and diffusion



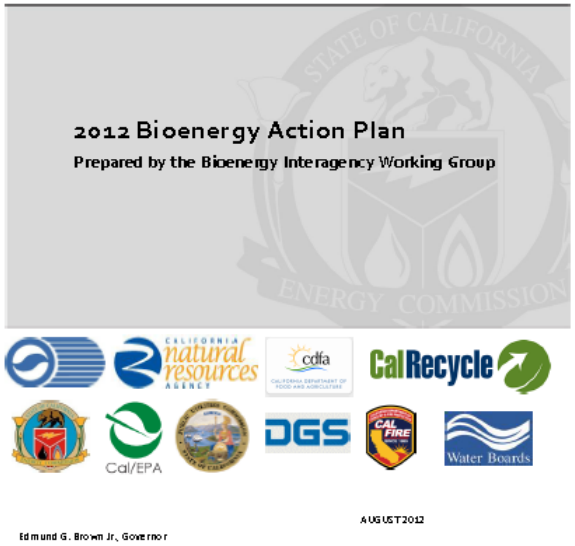
Barriers/Gaps/Opportunities



CA ZEV Action Plan



DOE H2/FCV Program Plan



CA Bioenergy Action Plan

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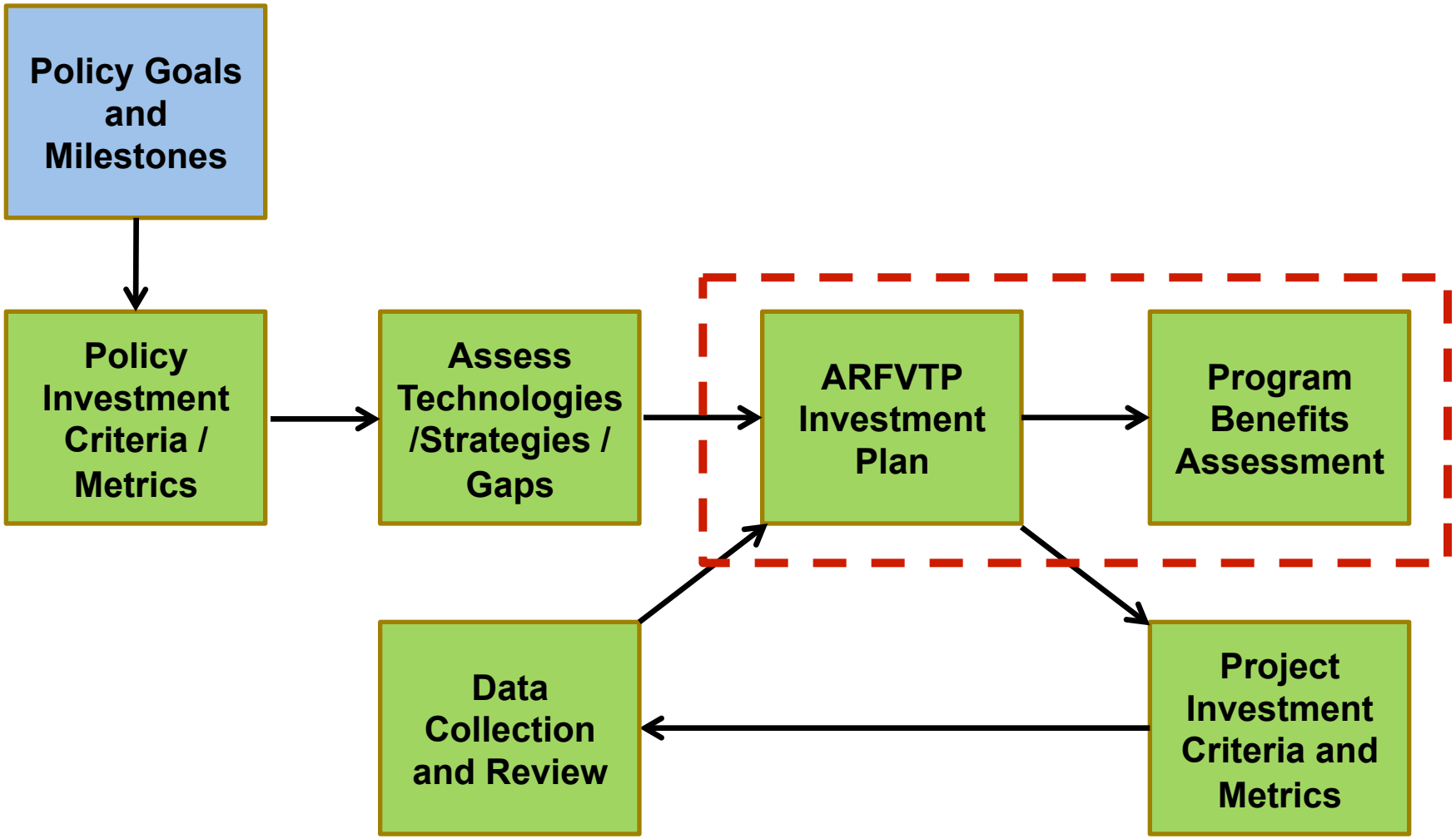
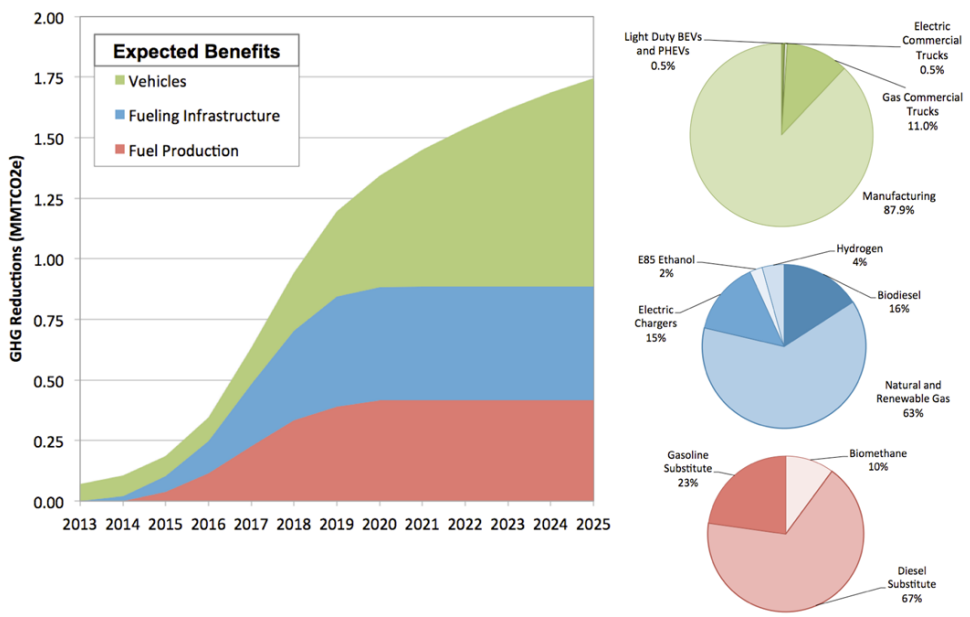
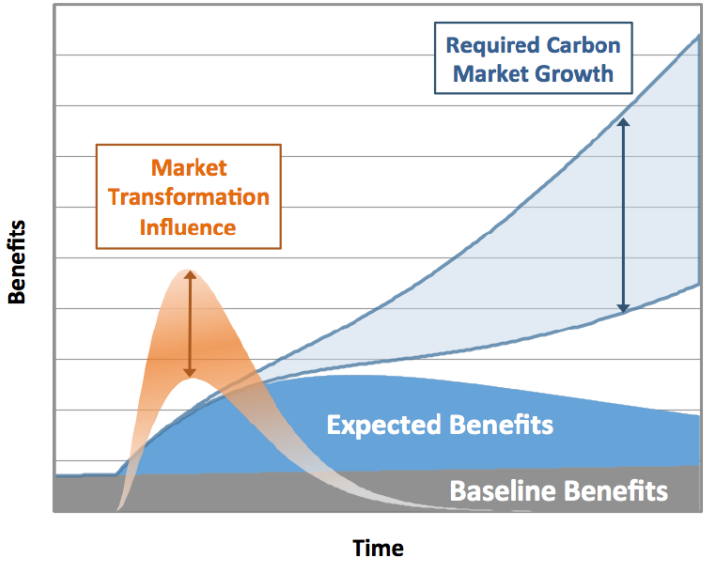
Investment strategy step by step – Illustrative



PROGRAM BENEFITS ASSESSMENT

Expected Benefits: GHG Reductions





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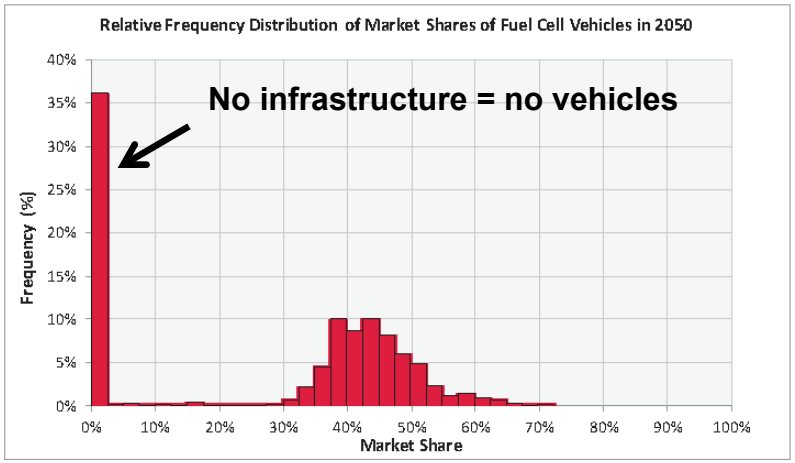
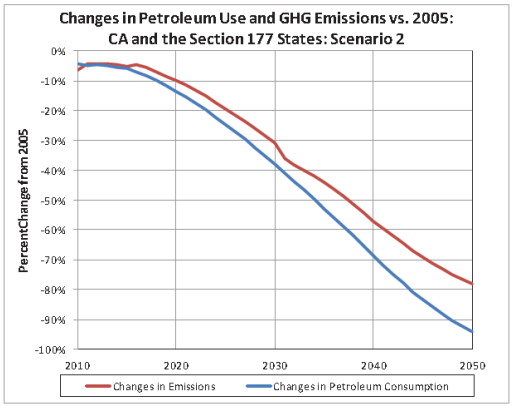
Source: Melaina, NREL

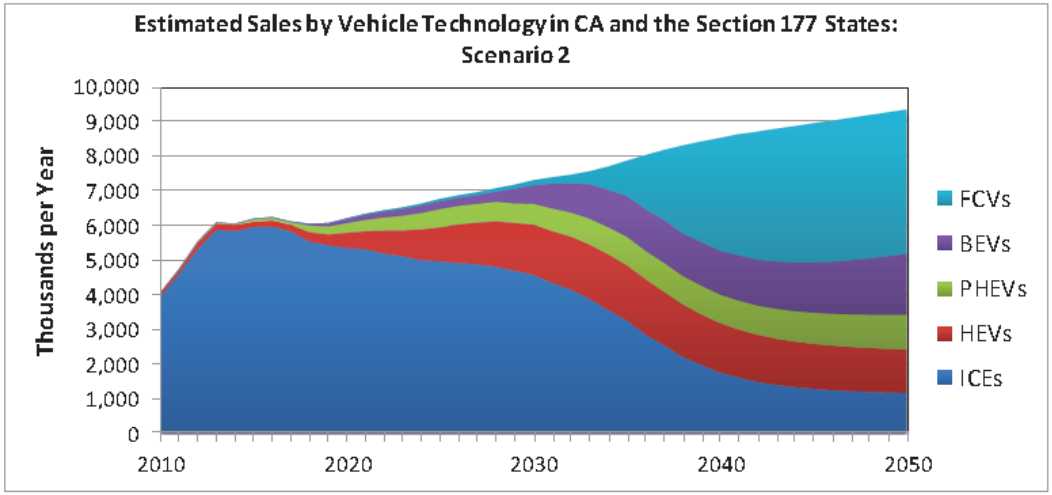
PROGRAM BENEFITS ASSESSMENT

Key findings:

- ZEV's could contribute to a ~80% reduction in LDV GHG and 90%+ reduction in petroleum by 2050
- A transition to ZEV's could provide very large public and private benefits well in excess of transition costs
- Net present benefits of transition scenario = ~$190B in CA and 177 States (energy savings alone exceed subsidy by $54B)
- Policy matters (infrastructure, incentives, etc.)







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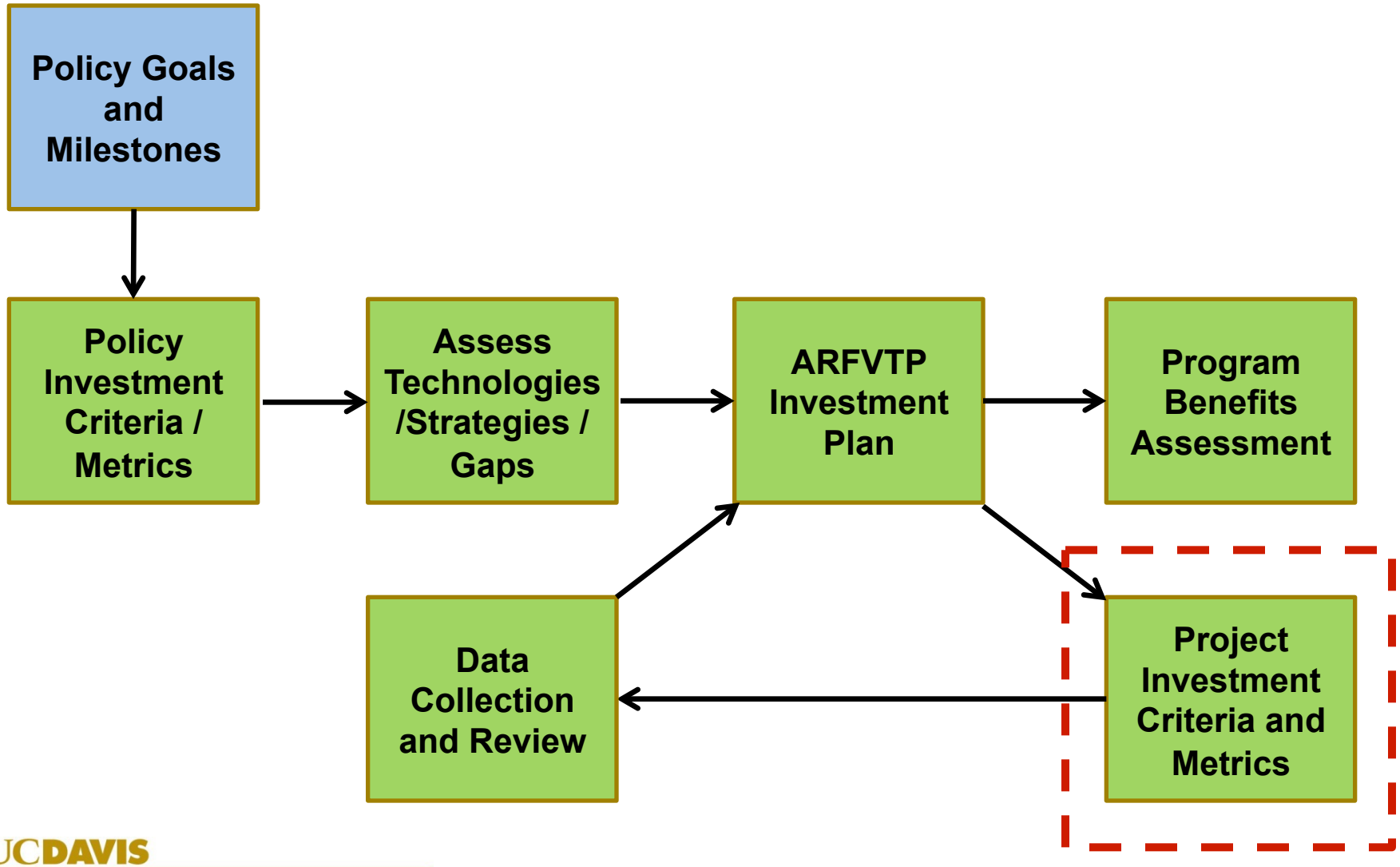
Source: Greene, D. et al. "Analyzing the Transition to Electric Drive in California", White Paper 4.13, April 23, 2013

Investment strategy step by step – Illustrative



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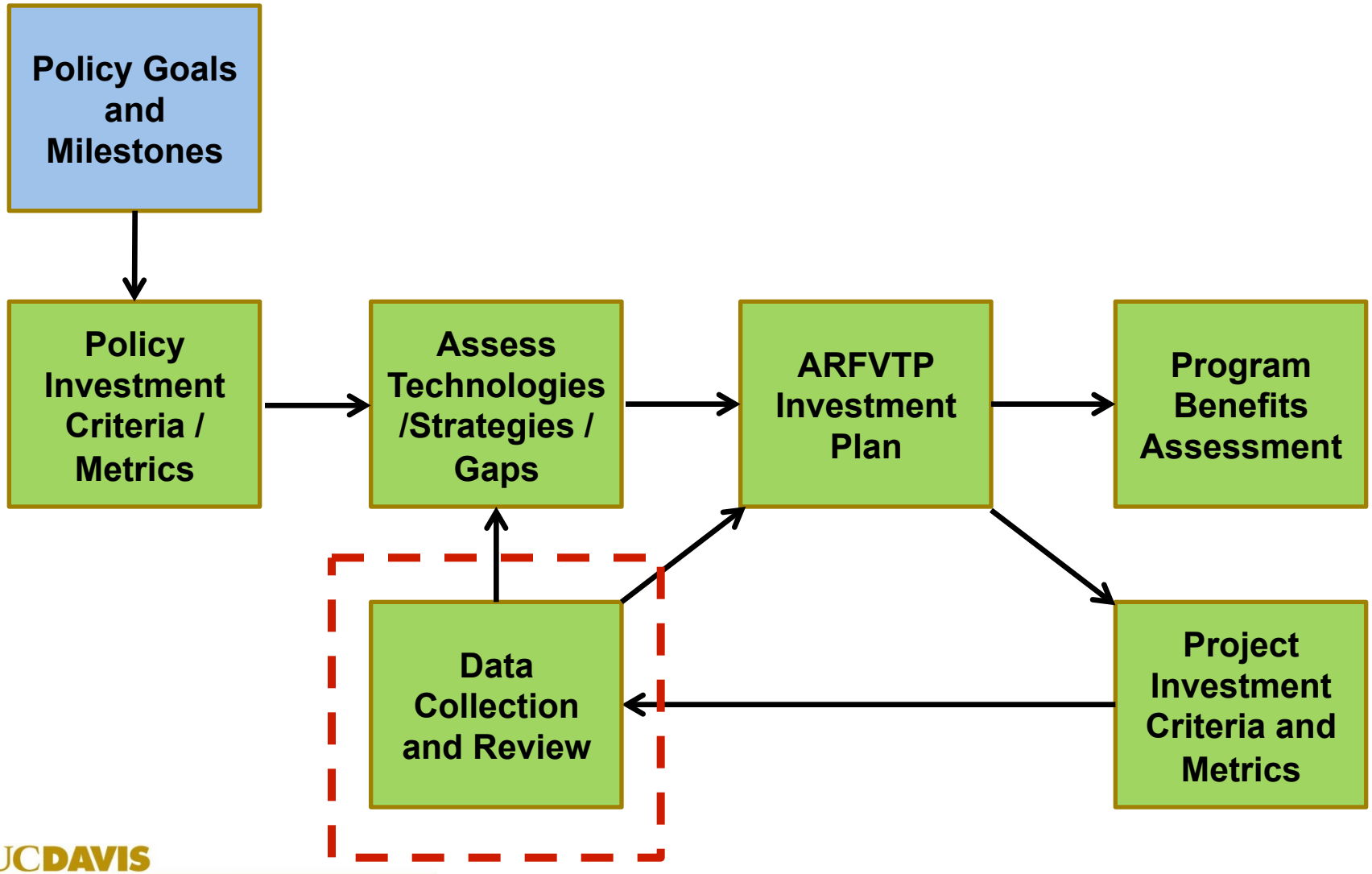
The appropriate project criteria depend on what it is you are trying to accomplish

Investment Type	Potential project-level metrics
Fuel Infrastructure	Number of Stations
	$/Station, $/GGE
	Compatibility/Interoperability
	Vehicles served (coverage and capacity)
	Fuel produced/sold
	Codes/Stds implemented
Vehicles	$/Vehicle, $/mile
	Pollution reduced (GHG, NOx, etc.)
	Vehicles produced/sold
Fuel Production	$/GGE, capital cost
	Life cycle pollution reduction
	Production capacity, capacity factor
Manufacturing/Workforce training	# jobs/placement
	Mfg investment / output ($, units, etc.)

Investment strategy step by step – Illustrative



Measuring impact – data collection and review

1. Provide contract mechanisms and resources for objective data collection and analysis
2. Consider 3rd party, expert, non-conflicted review of projects (post-award) and programs
3. Use data and review to adapt investment strategies, end unproductive projects/programs, and provide further evidence and understanding of program benefits.
4. Do → Learn → Adapt

Thank you!

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Extra Slides

EXAMPLE: 'Advanced' Biofuel Feedstocks in EU: Metrics & Decision Tree – Policy Focus

Feedstock	Bio fraction of MSW	Used Cook Oil
Global 2020 potential (PJ/yr)	3,253	266
Feedstock price (£/GJ)	-6.5	20.1
Biofuel production cost (£/GJ)	18	20
Key competing uses (substitutes)	Landfill (none), Heat & Power (nat gas), compost (fertilizer, peat)	Household disposal (none)
Potential Price Impact	Medium	Medium
% GHG Savings (direct emissions only)	80%	82%
Cost of GHG saving (£/tCO2e)	120	12
Additional support?	**Yes (depending on conversion technology)**	**Yes, where sustainable additional potential exists**

ILUC Mitigation

Best bets	**Biofraction C&I waste, Animal manure, Micro- or Macro-algae**
Conditions	**Straw, Sewage sludge, Empty palm fruit bunch, Bagasse, Cobs, Bark, branches, leaves, Small roundwood, Waste carbon gases**
Replacement	**Tall oil pitch, Nut shells, Husks, Sawdust, Black/ brown liquor, Animal Fats**
	Miscanthus, Short rotation coppice or forestry
Risky	**Crude glycerine, Grape marcs, Wine lees**

(E4Tech Report for UK)